Banded structure of the electrodeposited nanocrystalline Al-Mg alloy dendrites

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Al-Mg powders were electrodeposited using an organometallic-based electrolyte with composition Na[$AlEt_4$] + 2 Na[Et_3Al– H–$AlEt_3$] + 2.5 $AlEt_3$ + 6 toluene (where Et = -C_2H_5). A rotating cylinder electrode cell setup was used to produce these powders at an apparent current density of 60 mA cm^{-2} and at 60 ^oC. The electrodeposited Al-Mg dendrites possess super saturated metastable phases with nanocrystalline structure in dendritic form. These dendrites exhibit globular morphology with several stacks of smooth globules possessing face centered cubic (fcc-Al(Mg)) phase. Eventual formation of rough hexagonal close packed (hcp-Mg(Al)) globular morphology is observed over these smooth globules with the progress of deposition. The longitudinal sections of these rough globules exhibit alternating bright and dark banded structure under backscattered electron (BSE) mode in scanning electron microscope (SEM). These alternating bright and dark bands correspond to Mg-poor and Mg-rich compositions respectively. The compositional fluctuations are explained by considering the fluctuations in global potential (E)-time curve. More negative potentials result in Mg-rich dark bands, whereas Mg-poor bright bands appear at less negative potentials. A mechanism is proposed for the banded structure formation in Al-Mg dendrites considering the possible local potential fluctuations at nanometer level. The proposed mechanism is used to formulate novel theory of dendritic formation in nanoscale polycrystalline dendritic materials.

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